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COMPLIMENTS OF AUTHOR.

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RELATION OF EYE AND SPINAL DISEASES,

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When ophthalmology had first succeeded in establishing itself as a specialty, it was feared by many that it would gradually alienate itself completely from general medicine and surgery. The many new terms which it introduced and the intricate methods of exploration which it taught, made the communications which issued from those who had devoted themselves so zealously to it, contribute much to the apprehension that had from the first been entertained. The general advancement which had been effected in this department of science soon suggested what might be accomplished in other departments by similar work, and for a while it appeared that a general disintegration would ensue, as one new specialty after another, with its host of earnest devotees, presented itself so prominently to the consideration of the general profession. The result, however, has been different from what was anticipated, and ophthalmology was in the van in showing allegiance to the general science. Whatever manifested itself in the eye during general disturbances, or whatever injurious influence reached it from diseased conditions of distant organs, or whatever trouble it became involved in from having a suffering neighbor, was carefully studied; the relations indicated so that the symptomatology of the general clinician was increased thereby, and it has often occurred that a careful exploration of the eye has revealed serious disease of other parts, which, in the absence of other symptoms, would have, at least for a time, been entirely overlooked.

It has been satisfactorily demonstrated that the many wonderful links by which the various parts of the system are so intimately bound to each other, will not permit the complete isolation of any



specialty. More than this—the various specialties, in exploring distant regions, often meet each other and mutually extend the helping hand. Very close alliances have thus been formed, particularly between ophthalmology and neurology, in defining the relations of brain and eye diseases on the one hand, and spinal and eye diseases on the other. It is the latter subject which has been chosen as the subject of this report.

It has long since been realized that spinal diseases not unfrequently involve the eye. Especially has this fact been pointed to in connection with *Tabes dorsalis*, but it has also been found that other lesions of the cord must be charged with a share in producing the eye troubles under consideration.

With regard to the percentage of eye troubles in affections of the spinal cord, there have not been furnished sufficiently large statistics upon which a correct estimate could be based. Von Graefe estimated that in all cases of progressive atrophy of the optic nerve, thirty per cent. (30%) would have to be placed to the account of spinal diseases. Leber, in 87 cases of optic nerve atrophy which came under his observation in a given time, found 23 cases which exhibited spinal symptoms; that is, in 26 per cent. of the cases. In consulting the statements concerning the frequency with which optic nerve disease occurs as a consequence of spinal lesions, we must not be unmindful of the fact that it not seldom happens that the optic nerve presents the first symptoms occurring in the disease. Indeed, in some cases the eye symptoms may precede by many years the characteristic signs of spinal lesions. If we take this in consideration, it becomes extremely probable that in the statistics that have been tabulated by various authors, many cases of optic nerve atrophy have been excluded from the series that have been accompanied by spinal symptoms, which, however, in their future development proved to have owed their origin to the same distant cause. According to Charcot, the amaurosis may be the first, and for a long time the only symptom manifested, and a period of time as long as ten years may elapse before the pains and characteristic motor disturbances become established.

We must still further consider that the optic nerve is not the only part of the eye which is assailed in spinal affections, but that there are quite a number of cases in which contracted or dilated pupils are observed, and, furthermore, cases in which disturbances in the external muscles of the eye occur.

Cyon, who has collected the record of 203 cases of locomotor ataxy, finds the various eye disturbances manifested in 105.

Erb,* in referring to the muscular anomalies, makes the statement that if we embrace them all in the estimate, including the slight and transitory disturbances, differences in the pupils, spinal myosis, we have them in more than one-half the cases; more prolonged and permanent disturbances, on the contrary, may probably not arise in more than one-third or one-fifth of all cases.

Tropinard found in 102 cases, visual disturbances in 49.

As has already been stated, it was through the study of the varied symptoms of locomotor ataxy that the revelation came to us that spinal disease not unfrequently involved the visual apparatus. And while this form of spinal lesion still furnishes the largest number of cases in which visual disturbances are observed, they are also quite frequently met with in multiple sclerosis of the brain and spinal cord, in chronic myelitis, in slow compression of the cord, in injuries of the spinal cord, and in recent times we have been furnished with the evidence that cases of acute myelitis are not entirely free from this complication.

When Erb wrote upon nervous disorders in Ziemsen's Encyclopedia he was not yet aware that acute myelitis could involve the eye, for he states that "disorders of the optic nerve, of the nerves supplying the muscles of the eye and other cerebral nerves, which play such a prominent role in chronic myelitis, are unknown in acute myelitis."

Allbutt found five cases of acute myelitis which presented visual disturbances, but it is not mentioned whether these depended upon atrophy of the optic nerve. Steffan first led the way to the investigation of optic nerve degeneration due to acute myelitis.† He has been followed by very important observations in this direction by Seguin, Noyes, Rumpf, and quite recently by Nieden.

The large field for the study of the connection of eye and spinal affections which these varied etiological sources have furnished has still further been extended by the valuable conjoined researches of Rieger and von Forster.‡ These investigators have been enabled to show by an extensive study of the symptoms of insane paralytics, and by satisfactory post mortem examinations, that the optic nerve degeneration which accompanied these cases was not due to the cerebral lesions,

* Vol. 13, p. 580, Ziemsen's Encycl.

† Versammlung der ophthalmologischen Gesellschaft, Heidelberg, 1879.

‡ Auge und Rückenmark, von Dr. Rieger in Würzburg und Dr. von Forster in Nürnberg, Graefe's Archiv f. Ophthal., Vol. 27, part 3.

but had to be referred to the disease of the spinal cord that was concomitant in these cases.

The relations of eye diseases and brain affections had of late years been made so clear, that any case that was accompanied by the slightest brain symptoms was attributed to an intracranial cause; no matter what spinal symptoms might have coexisted, they were generally ignored, so far as any connection between them and the eye disturbance was concerned. They reached these conclusions by observing, that although meningitis and atrophy of the cortical substance of the brain had existed, the eye symptoms were always wanting, unless disease of the spinal cord had also been found.

How a disease of the spinal cord could involve the eye has long been an unsolved problem. A glance at the different course which the optic nerve affection pursues, in the two most prominent spinal diseases, locomotor ataxy and multiple cerebro-spinal sclerosis, leads at once to the recognition of the fact that the eye is not assailed in these two diseases in the same way. In ataxy, when the optic nerve becomes implicated, we encounter a diseased condition which is of a progressive character. We do not observe in these cases any arrest of its development; the amblyopia which first manifests itself is observed gradually to become more and more marked, until finally, total amaurosis is established. In multiple sclerosis, on the contrary, the optic nerve has seldom been observed to have undergone complete atrophy, and, consequently, while persons suffering with an eye complication in this disease will have impaired vision, they will extremely seldom be found to have been rendered completely blind.

When the vision becomes impaired in locomotor ataxy, certain alterations in the appearance of the optic nerve will be revealed from the first, showing that a certain degree of atrophy has occurred. In multiple sclerosis, according to Steffan,* a considerable amblyopia may present itself, and the optic nerve may not reveal anything abnormal in its appearance. And even when a certain degree of atrophy has been discovered, the impaired vision which has been found to co-exist, may be found in the further observation of the case to have become considerably improved. When the optic nerve has been assailed in locomotor ataxy, we will not observe a similar fluctuation in the vision, nor will even a temporary cessation in the danger which threatens be noticed.

* *Loc. cit.*

We must conclude from these important differences in the clinical aspect which these cases present, that the pathological anatomy of the diseased nerves must vary greatly. Indeed, from the general pathology of the disease, we may assume that in multiple cerebro-spinal sclerosis, the optic nerve affection does not depend upon any direct influence of the diseased cord, but that from the diffused character of the disease, both the cord and the eye are independently attacked. We can readily understand that a pathological process, that travels over so extended a ground as does multiple sclerosis, can in its full development also reach the optic nerve, without regarding the disease of the latter as due directly to the disturbance in the part originally affected. And in this sense, multiple sclerosis is to be excluded from the category of diseases of the spinal cord which have a direct influence in establishing changes in the eye.

But how are we to regard the relations between the eye trouble and the spinal disease when the former appears as the undoubted consequence of the latter? The simplest explanation that suggests itself is, that an inflammation, having reached the spinal meninges, has ultimately extended to the meninges at the base of the brain, and finally to the optic nerves. While this theory must be left uncontroverted as a possibility in the acute cases that have ended in resolution, it cannot be accepted as an explanation of the chronic forms, for it is neither sustained by the symptoms nor by the autopsy.

That a diseased condition of the spinal cord can induce changes in the distantly situated optic nerves, as a direct consequence, we are forced to accept as a fact, by the history of acute cases, especially those due to traumatic lesions, and furthermore by the result of physiological experiments, to which we will hereafter refer; and we are forced to assume, in the absence of any apparent continuity of disease in the parts situated between the diseased cord and the affected eye, that the injury is transmitted by a vaso-motor disturbance, conveyed in the tract of the sympathetic nerve.

In studying the method of transmission of a pernicious influence from a diseased cord to the optic nerve, we must not overlook a way-station between the affected parts, which Stilling's investigations, in tracing the roots of the optic nerve in the medulla oblongata, have brought to our notice. If we grant that a spinal lesion might first assail that part of the medulla from which the optic nerve roots are said to arise, no extra messenger would be required to explain how the disease was conveyed to the optic nerve, provided that the optic

nerve degeneration showed a centrifugal development; but on the contrary, the anatomical investigations that have been made have proved that the disease in the nerve begins at its terminal part and spreads in a centripetal direction. Besides this, we would still have to search for the method by which the disease is carried from the cord to the medulla, the parts intervening remaining intact. If future investigations will demonstrate that the medulla may be implicated, we will still require the theory which has been mentioned, namely, a vasomotor disturbance, to indicate the journey of a diseased influence from the cord to the optic nerve, with the modification that that influence has made two instead of one leap, but in the same direction; in either event the eye trouble must be regarded as equally dependent upon the spinal lesion.

The most conclusive testimony regarding the optic nerve degeneration being due to the direct influence of spinal disease, is furnished by those cases which have had a traumatic origin. Allbutt* found in thirty cases of well-marked spinal injuries, eight cases in which eye disturbances occurred; they accompanied those which followed a chronic course, that is to say, the cases which had sustained a less severe injury, of which there were thirteen; in the other seventeen, which terminated in death in a few weeks, no alteration in the eye appeared.

Mooren† reports a case in which a blow with the flat of the hand, causing syncope which lasted half an hour, was followed by heaviness of the lower extremities, and in the further course, by progressive optic nerve atrophy, terminating in blindness and accompanied by other spinal symptoms.

Bruce Clarke‡ reports four cases, three of simple concussion of the spinal cord, and one of fracture of the vertebra. In these, "early transient changes of the optic disk were observed. They could not have been even suspected without periodical ophthalmoscopic examinations. The appearances noticed consisted of hyperæmia and sometimes oedema of the optic disk."

Bull,§ in examinations which he conducted in cases of Potts' disease, found that while the optic nerve was free from any destruc-

* On the Ophthalmoscopic Signs of Spinal Disease, *Lancet*, Vol. 1, p. 76, 1870.

† Ophthalmologische Mitth., 1874, p. 95.

‡ London *Medical Record*, 1881, p. 166, April 15th.

§ Eye Lesions in Affections of the Spinal Cord, *American Journal Medical Sciences*, July, 1875, p. 70.

tive alteration, the branches of the vena centralis retinae were large and tortuous, the minute nutrient vessels of the nerve increased in number and size, the enlargement being occasionally also noticed in the arteria centralis retinae.

In the cases of Allbutt, quoted above, hyperæmic conditions of the fundus oculi were found associated with the amblyopia.

The discovery of vascular disturbances in the above-mentioned cases has a very important significance. Von Graefe rejected the idea that an optic nerve atrophy could directly be due to spinal disease, for the reason that he had never observed the atrophy of the nerve in these cases preceded by hyperæmic conditions, pointing to an optic neuritis as the beginning of the eye disease, as is commonly the case in atrophy following intra-cranial causes. He viewed the optic nerve complication and the spinal lesions due to a common cause, affecting different parts of the nervous system independently of each other.

In addition to the hyperæmic conditions that have been found in the traumatic cases, we have the complete symptoms of optic neuritis found in association with the acute cases that have already been mentioned, to show that it is very probable that the atrophy which has been regarded as the starting point of the eye disease, is but the consecutive expression of a previously existing inflammation.

Wharton Jones,* as far back as 1869, first announced the theory that the disease of the optic nerve in spinal lesions was in general due to disturbance of the sympathetic nerve, leading first to paralysis of the vasomotor nerves and to hyperæmic conditions, and later to atrophy of the optic nerve.

The objection which Von Graefe first offered, namely, the absence of hyperæmic conditions previous to the atrophy, greatly retarded its acceptance. The force of this objection has been greatly shattered, not only by the hyperæmic conditions which the ophthalmoscope has revealed in connection with acute and traumatic myelitis, but also by the investigations of Rieger and von Forster,† who have been able to report two cases of spinal disease of chronic form in which well-marked intercurrent hyperæmic conditions were observed.

It has been claimed that the eye disturbance often taking place long in advance of the spinal symptoms, deprives the theory of Wharton Jones of plausibility. Indeed, this circumstance has been

* On the Occurrence of Amaurotic Amblyopia, long after the injury, in cases of Concussion of the Spinal Cord, *Brit. Med. Jour.*, July 2, 1869.

† *Loc. cit.*, pp. 117; 118.

adduced as evidence to prove that the eye-trouble is entirely independent of the spinal lesion. It must be borne in mind, however, that these opinions were proclaimed before the importance of the tendon reflex, as a means of diagnosis in spinal affections when other phenomena might still be in abeyance, was discovered. Rieger and von Forster, in a number of cases of optic nerve atrophy, were enabled, principally through the absence of the tendon reflex, to detect that the cord had simultaneously been affected. It may safely be assumed that the atrophy of the nerve which is generally discovered as soon as disturbance of the vision is complained of, has been preceded by vascular disturbances; for in connection with choked disk, we have long since learnt that this may exist, and that too, to a very high degree, as is often discovered by the neurologist, long before any impaired vision follows.

In arriving at this conclusion we need not simply be governed by the experience that vascular disturbances play so prominent a role in the initiatory stages of those conditions which lead to atrophy of the optic nerve in intracranial disease. In the frequent occurrence of changes in the pupil in spinal affections we have very strong evidence of the complicity of the sympathetic nerve, and physiological experiments have long ago taught us that its innervation is accompanied by hyperaemic conditions. It is true that the vascular disturbances referred to were observed in the integument of the face and neck, on the side upon which the cervical sympathetic had been operated on; and it is of great interest to know in what manner the retinal circulation would be affected under these circumstances.

Rieger and von Forster report the following experiments: Irritation of the exposed cervical sympathetic in rabbits, with a strong inductive current, at a point 5mm. below the superior cervical ganglion, up to the ganglion itself, caused, in the case of two rabbits, very considerable contraction of the retinal vessels, which, after the interruption of the current, disappeared in one and a half minutes; the contraction of the vessels being always accompanied by wide dilatation of the pupil.

After the cervical sympathetic had been cut and the ganglion removed, in four cases no immediate effect was observed; but on the next day, and for several days after, until the animal died, the retinal vessels on the side of the operation remained dilated.

With regard to the simple irritation of the exposed nerve, the result corresponds with what we have previously known, namely, that it

would cause contraction of the radiating fibres of the iris; and the contraction of the muscular coat of the vessels, which was also found, is in perfect harmony with this condition of the pupil. That, however, there should be no immediate result following when the nerve was severed and the ganglion removed, is rather a surprise; for the experiments of Claude Bernard and others have taught that among other phenomena, contraction of the pupil would invariably be produced. The dilatation of the retinal vessels, which took place the day after the operation, indicates how vascular disturbance may precede optic nerve atrophy, through the influence of the sympathetic, and suggests further how it possibly may be called forth in spinal disease.

Three clinical observations, which Rieger and von Forster report, are exceedingly interesting as showing the complicity of the sympathetic in assaults upon the eye, in which, however, the spinal cord was not involved. Time will not permit me to give these cases in full. The first of the group exhibits optic nerve degeneration, with unmistakable symptoms of vaso-motor disturbances about the face. In the second we are shown that a double struma, exerting pressure upon the cervical sympathetic, caused a peculiar discoloration of the face, and hyperamia and swelling of the optic disk with impaired vision. In the third there was exhibited the external manifestation of disturbance of the sympathetic, and the symptoms of a very destructive form of inflammation, of which a plastic iritis and increased tension were the prominent features. In the study of exophthalmic goitre, which, it is conceded, depends upon a disturbed condition of the sympathetic, we have been made acquainted with the hyperamic conditions by which this disease is attended, but in these observations neither inflammation nor atrophy has been observed. The cases just cited have therefore an important significance, showing as they do that under certain conditions the hyperamia, which was heretofore known to occur in disturbances of the sympathetic, may go one step farther and assume the full character of an inflammation, and finally result in degenerative changes.

The experiments which Rieger and von Forster made upon the cord, in supplementing those previously made upon the cervical sympathetic, are exceedingly interesting. A strong induced current with sharp electrodes was sent through the lumbar vertebrae, being so directed that it had to pass through the cord. Tonic spasm of all

the muscles supervened. After one minute the current was interrupted, the retinal vessels were slightly contracted, and the pupils were dilated *ad maximum* and remained in this condition for some time. At first the animal was unable to move, and the patella reflex, which had been readily induced before, was now found to be entirely wanting.

In a second experiment the sharp electrodes were applied to the previously intact integument between the fourth and sixth dorsal vertebrae, and pushed through in a direction that they reached the arch of the vertebra on either side. A medium induced current was employed for five seconds, by which dilatation of the retinal vessels was produced, and in a few seconds more very decided dilatation of the retinal vessels followed. The experiment was repeated five or six times with the same current, sometimes with negative results; but whenever the pupils dilated the dilatation of the vessels followed soon after. If the current was greatly increased, suddenly the vessels became anaemic, the papilla pale, the pupils contracted, and death of the animal supervened. The autopsy, which was undertaken immediately after, showed that all the abdominal and thoracic organs, the brain and its meninges, were anaemic. A very large amount of blood was found occupying the vertebral canal, from the first dorsal vertebra to the end of the canal and compressing the cord. The hyperaemia terminated abruptly at the seventh cervical vertebra, from which point upwards the canal was anaemic.

In a third experiment the vertebral canal was opened at a point corresponding to the first dorsal vertebra, and the needle electrodes were introduced from behind without any special reference to what part of the cord was struck. A very weak current was used. Both the pupils and the vessels dilated, and as the experiment was prolonged, convulsions supervened and the animal died, the vessels and pupils having contracted just before. The same result was found as in the previous autopsy.

It will be observed that the irritation of the spinal cord was accompanied by quite different results in the eye than when the experiment was directed to the cervical sympathetic; and furthermore, a difference was observable in the direct irritation of the cord when different points were selected. When the cervical sympathetic was chosen for the experiment we find contraction of the pupil and contraction of the retinal vessels. When the lumbar portion of the cord was operated on there resulted dilatation of the pupils and contraction of

the vessels, and when the dorsal portion of the cord was experimented on we find that both dilatation of the pupils and dilatation of the vessels occurred.

One fact certainly has been satisfactorily established in these experiments, namely, that an irritation of the cord will set up hyperæmic conditions of the optic nerve, although from the varied results of the different experiments it might be objected that the influence from the point of irritation in the cord is not carried to the optic nerve by way of the sympathetic. It cannot, however, be denied that the sympathetic nerve may, under certain circumstances, be the medium through which the eye is reached in spinal diseases, for, in addition to other evidence, we have the observation of Basch,* who has seen the dilatation of the retinal vessels as a result of irritation of the splanchnic nerve; on the other hand, it cannot be claimed that when disease of the cord implicates the eye that it always travels in the same path.

With regard to the differential diagnosis of optic nerve disease as a result of spinal lesions, the great expectations that have been indulged in in reference to the ophthalmoscope have as yet not been realized. And while there are those who speak of peculiarities in the hyperæmic stage, and of characteristic discolorations of the optic disk in the stage of atrophy, there would hardly be one who would venture a diagnosis upon these alone. The examination of the functions of the eye may, however, yield very important data. Prominent among these are the red-green color-blindness, and the contracted field of vision, especially the sector-shaped defects that will frequently be manifested. Another very significant symptom in distinguishing this from other forms of atrophy is the increased sensibility to light. Not only will such patients see better in twilight, but sometimes when they are almost entirely blind they will still complain of the distressing effect of bright light. When spinal symptoms are already developed the diagnosis is comparatively easy; and in the absence of those ordinarily looked for, the examination of the tendon reflex will often lead to the detection of spinal disease, when other symptoms, by which this condition is more commonly attended, may not yet have made their appearance. Westphal† first called the attention of the ophthalmologists to the importance of the tendon reflex as a diagnostic aid in all cases of optic nerve atrophy, and urged its

* Arbeiten d. Leipziger Physiologischen Instituts, 1875.

† Berliner Klin. Wochenschrift, January, 1878.

employment with a view of determining whether it constitutes an early symptom of locomotor ataxy.

Uthoff's* investigations incline to this conclusion, and in his cases, in which spinal symptoms were present, the patella reflex was almost invariably absent. In only two of his fifteen cases could the patella reflex be demonstrated, and in these the spinal symptoms were very well marked. In twenty-four cases of progressive optic nerve atrophy, there were seven in which the patella reflex was absent. In these cases there was nothing to indicate that they were due to diseases of the cord, but there was one among them in which, after three months, spinal symptoms became developed. Probably if the others could have been followed, similar results would have been observed. In sixteen cases of atrophy of the optic nerve, due to cerebral diseases, eight of nine in adults showed that the tendon reflex was maintained; in the others the patients were too young for satisfactory examinations.

With regard to the changes noticed in the pupil in spinal diseases, there is nothing that can be pointed out as peculiar when the pupils are dilated; but when the pupils are contracted we find a condition that seems to be quite characteristic. The peculiarity alluded to consists in the phenomenon that this contracted pupil undergoes no alteration whether the patient be brought into a dark chamber or be exposed to the most intense light, but still exhibiting changes with the efforts of accommodation. With regard to the frequency of spinal myosis, Uthoff found it present in nine cases of fifteen. To Argyle Robertson is due the credit of having first pointed out the characteristic features of spinal myosis.† His observations were soon fully verified by Knapp,‡ Leber,§ Hempel,|| and others, and it may be regarded as one of the principal symptoms in the differential diagnosis of optic nerve atrophy due to spinal diseases.

We now arrive at a point in our studies where we must turn our attention to another form of eye symptom in spinal affection, namely, the disturbances of the muscles of the eyeball; and here we approach the most obscure part of our subject. Both the alterations found in the optic nerve and in the pupil can be explained by disturbance of the sympathetic. There is nothing in the nature of the affection of

* Beitrag zur Sehnervenatrophie, Graefe's Archiv für Ophthal.

† Edinb. Med. Journal, 1869.

‡ Archiv für Augen und Ohrenheilkunde, 1872.

§ Virchow-Hirsch's Jahreshb. 1872.

|| Ueber die Spinalmyosis, Graefe's Archiv, 22 a.

the muscles of the eyeball, however, which points to a similar origin. It has been found that the paralysis of the muscles of the eyeball appears as a very early symptom in the spinal disease; sometimes assuming a very transitory character, at others persisting obstinately. The muscles supplied by the fourth pair of nerves seem to enjoy almost entire immunity in these conditions; those supplied by the third and sixth pairs are attacked with almost equal frequency. Sometimes the motor oculi of one eye will be involved, while the abduceus of the other alone has suffered.

The paralysis of the muscles of the eyeball occurring in syphilis bears a great resemblance to that met with in spinal lesions, presenting the difference, however, that complete paralysis of the motor oculi is more frequently observed in the former. Rieger and von Forster have so frequently been able to trace syphilis antedating the symptoms of spinal disease that came under their notice, especially in those cases that were attended by such paralysis, that they were forced to infer that the paralysis had an independent origin in these cases. It might be said, in opposition to this opinion, that in excluding this group of symptoms from the general influence that passes from the cord to the eye, the whole theory of the dependence of the eye complication upon the diseased cord is seriously assailed. It must not be overlooked, however, that the principal support which the theory that the eye symptoms are produced by the spinal lesion, and are not a simple coincidence with it, has been received from what has been observed in acute cases of myelitis, in traumatic lesions, and in the physiological experiments to which the cord has been subjected, and in these cases the oculo-pupilar symptoms alone were manifested. It is to be hoped that further investigation will fully clear up the discrepancy which is noticed in this regard between the acute and chronic forms of spinal lesions.



